INTERNATIONAL STANDARD

ISO 3724

Second edition
2007-08-15

Hydraulic fluid power — Filter elements — Determination of resistance to flow fatigue using particulate contaminant

Transmissions hydrauliques — Éléments filtrants — Détermination de la résistance à la fatigue due au débit en utilisant un contaminant particulaire

Reference number
ISO 3724:2007(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3724 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

This second edition cancels and replaces the first edition (ISO 3724:1976), which has been technically revised.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. The fluid is both a lubricant and a power-transmitting medium. Filters maintain fluid cleanliness by removing insoluble contaminants. The filter element is a porous device that performs the actual process of filtration.

The effectiveness of the filter element in controlling contaminants is dependent upon its design and its sensitivity to any unsteady operating conditions that can stress and cause damage to the filter element.

Hydraulic fluid power — Filter elements — Determination of resistance to flow fatigue using particulate contaminant

1 Scope

This International Standard specifies a method for determining the resistance of a hydraulic filter element to flow fatigue after it has been loaded with particulate contaminant and subjected to a uniform varying flow rate and predetermined maximum element differential pressure.

It establishes a uniform method for verifying the ability of a filter element to withstand the flexing caused by cyclic differential pressures induced by a variable flow rate.

NOTE Annex A summarizes data from a round robin test performed to verify the procedure specified in this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 1219-2, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 2: Circuit diagrams*

ISO 2941[1)], *Hydraulic fluid power — Filter elements — Verification of collapse/burst pressure rating*

ISO 2942, *Hydraulic fluid power — Filter elements — Verification of fabrication integrity and determination of the first bubble point*

ISO 2943, *Hydraulic fluid power — Filter elements — Verification of material compatibility with fluids*

ISO 5598[2)], *Fluid power systems and components — Vocabulary*

1) To be published. (Revision of ISO 2941:1974)

2) To be published. (Revision of ISO 5598:1985)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

3.1
filter element resistance to flow fatigue
ability of a filter element to resist structural failure due to flexing caused by cyclic system flow rate conditions

3.2
maximum assembly differential pressure
Δp_A
sum of the housing differential pressure and the maximum element differential pressure

3.3
housing differential pressure
Δp_H
differential pressure of the filter housing without an element

3.4
maximum element differential pressure
Δp_E
maximum differential pressure across the filter element designated by the manufacturer as the limit of useful performance

4 Graphic symbols and circuit diagrams

Graphic symbols used in this International Standard are in accordance with ISO 1219-1 and circuit diagrams in accordance with ISO 1219-2.

5 Test apparatus

5.1 Pressure-sensing and recording instruments, with a frequency response capable of measuring the full pressure-versus-time curve (see Figure 1).

5.2 Flow fatigue cycle test stand, capable of varying the test flow rate from 0 l/min up to the rated flow rate (see Figures 1 and 2).

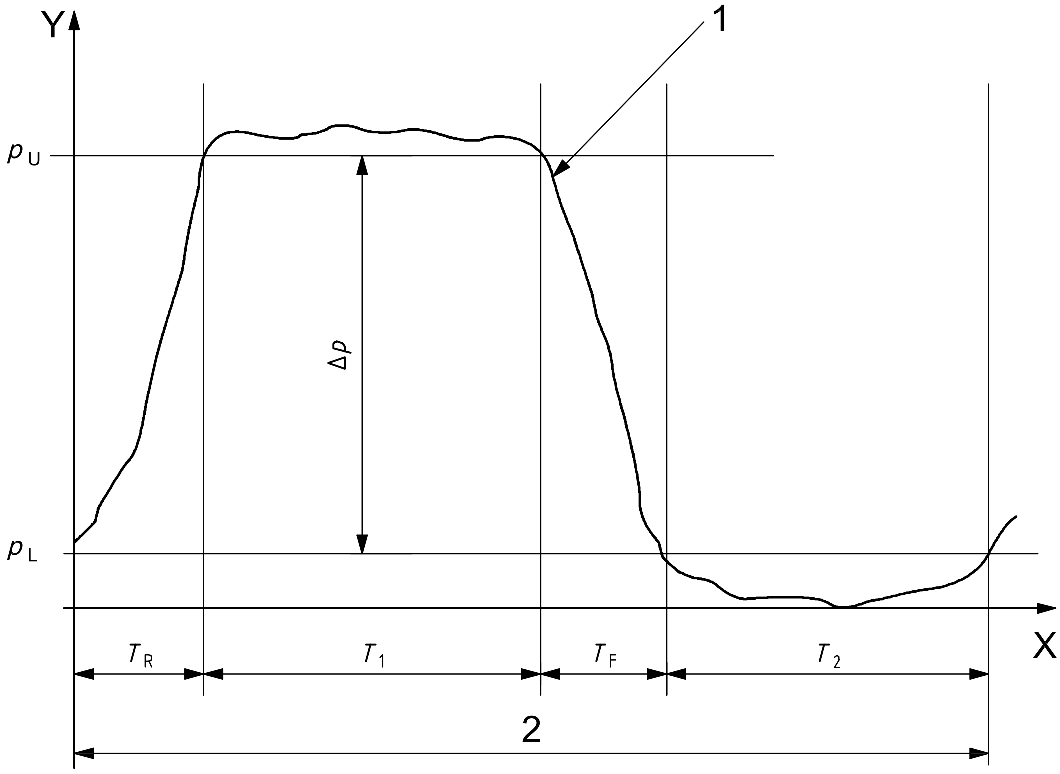
5.3 Test filter housing, capable of ensuring that the fluid cannot bypass the filter element. The filter shall be capable of being modified to suit this purpose.

5.4 Test fluid, with a viscosity between 14 mm^2/s and 32 mm^2/s at the test temperature. The compatibility of the fluid and filter element material shall be verified in accordance with ISO 2943. Any fluid that is compatible with the filter element material may be used.

5.5 Cycle counting device, capable of recording the number of flow fatigue cycles.

5.6 Inert particulate contaminant, not able to add strength to the filter element, used to load the filter element being evaluated.

NOTE Test dust according to ISO 12103-1 is suitable.



Key

X time (s)

Y pressure (kPa)

1 actual test pressure (kPa)

2 one test cycle, T

p_L lower test pressure; $p_L \leqslant 10\ \%\ p_U$

p_U upper test pressure; tolerance on p_U is ± 10 %

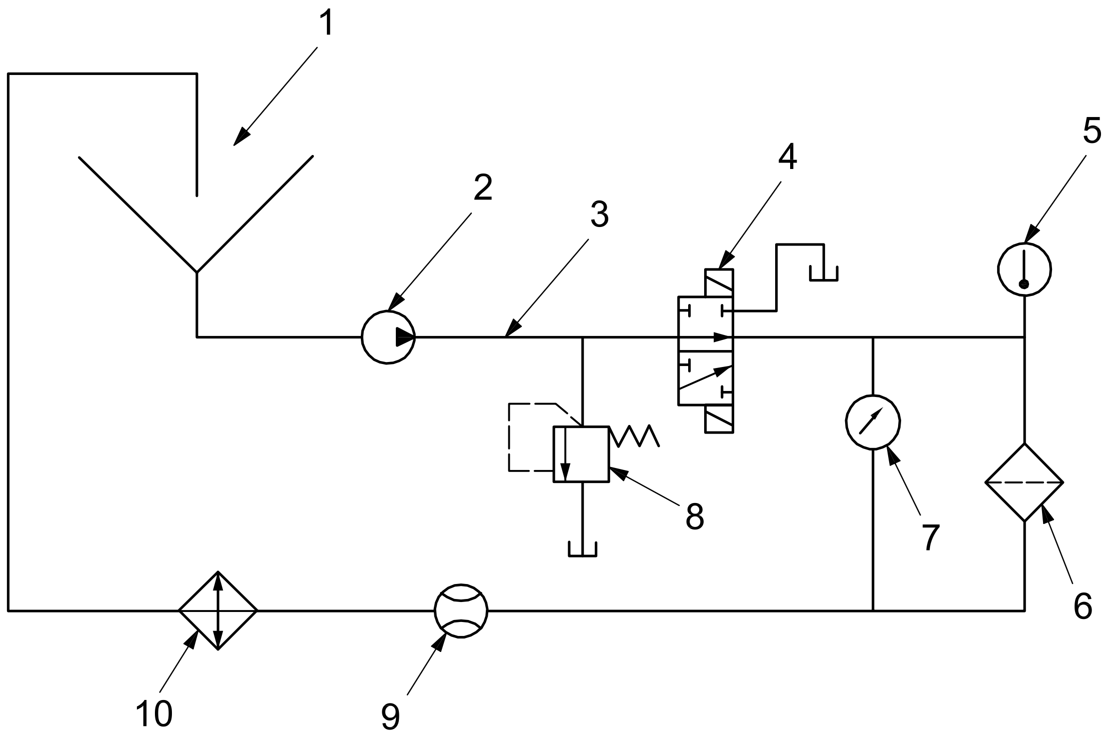
T_R rise time; $T_R = (15 \pm 5)\ \%T$

T_1 time at pressure; $T_1 = (35 \pm 5)\ \%T$

T_F fall time; $T_F = (15 \pm 5)\ \%T$

T_2 time without pressure; $T_2 = (35 \pm 5)\ \%T$

Figure 1 — Flow fatigue cycle test waveform



Key

1 contaminant injection
2 system pump
3 alternative point of contaminant injection
4 cycling valve
5 temperature sensor
6 filter under test
7 differential pressure transducer
8 relief valve
9 flow meter
10 heat exchanger

NOTE The circuit in this figure is simplified and includes only the basic components needed for conducting the test specified in this International Standard. Other components or additional circuitry (e.g. clean-up filter loop) can be used.

Figure 2 — Typical filter element in flow fatigue cycle test stand circuit

6 Accuracy of measurements and test conditions

Instruments used to measure test parameters shall provide a reading accuracy in accordance with Table 1. Test conditions shall be maintained within the tolerances specified in Table 1.

Table 1 — Instrument accuracy and allowed test condition variation

Test condition	SI unit	Instrument accuracy — Tolerance on reading	Allowed test condition variation
Flow rate	l/min	± 2 %	± 10 %
Differential pressure	kPa	± 2 %	± 10 %
Temperature	°C	± 1 °C	± 3 °C
Cycle rate	Hz	—	± 10 %

7 Test procedure

7.1 Subject the filter element under test to a fabrication integrity test in accordance with ISO 2942.

7.2 Disqualify from further testing any element that fails to pass the criteria specified in ISO 2942.

7.3 Install the test filter housing in the flow fatigue cycle test stand (see 5.2 and Figure 2).

7.4 Plot the curve of housing differential pressure (Δp_H) versus flow rate (q). Determine the test filter housing differential pressure from at least 25 % up to 100 % of the rated flow rate at the test temperature selected. Record the results in the test report (see Table 2).

7.5 Install the filter element in the test filter housing.

7.6 Calculate and plot the maximum assembly differential pressure (Δp_A) curve, corresponding to the predetermined maximum element differential pressure (Δp_E) plus the housing differential pressure (Δp_H), at the same flow rates as those given in 7.4. Record the results in the test report (see Table 2).

7.7 Add the test contaminant until the maximum assembly differential pressure (Δp_A) is reached.

NOTE 1 The filter element will need more contaminant in order for the maximum element differential pressure to be reached at 25 % of the rated flow rate. However, because the filter element can experience particle desorption due to the variation in flow rate, it is suggested that initial contaminant be injected at the minimum or intermediate flow rate (that is 25 % or other percentage of rated flow rate) until the maximum assembly differential pressure is reached. This approach can minimize the total amount of contaminant used throughout the test, as the differential pressure can be maintained by increasing the flow rate instead of adding more contaminant.

If it is advantageous to start flow fatigue cycling while loading the filter element to the maximum assembly differential pressure, ensure that the cycle counting device is reset to zero before proceeding to 7.8.

Initially, contaminant should be added in a uniform manner. For incremental injections, a mass of 5 % of the estimated filter element contaminant capacity per injection is recommended. Adjustments to the quantities of contaminant added and time intervals between injections may be required.

NOTE 2 The test can be interrupted and restarted as necessary. If the test is interrupted, additions of contaminant will most likely be required to regain the maximum assembly differential pressure.

7.8 Begin the flow fatigue cycle test. Each flow fatigue cycle shall consist of varying the flow rate through the filter element from 0 l/min to a flow rate between 25 % and 100 % of the rated flow rate and then back to 0 l/min, while maintaining the differential pressure-versus-time trace specified in Figure 1. The frequency of the test cycle rate shall be selected from the range 0,2 Hz to 1 Hz (inclusive) and shall remain constant within the tolerances given in Table 1 throughout the test.

A relief valve may be used (see Figure 2) and adjusted as necessary to limit peak pressure to the maximum assembly differential pressure within a tolerance of ± 10 %, as specified in the waveform shown in Figure 1. Contaminant may also be added periodically during the test to maintain differential pressure.

7.9 Monitor and control the assembly differential pressure by reducing or increasing the flow rate, as needed, between 25 % and 100 % of the rated flow rate.

7.10 Subject the filter element to the required number of flow fatigue cycles.

7.11 Obtain and present a typical differential pressure-versus-time trace for at least one cycle (see Figure 1).

7.12 Subject the filter element to a collapse/burst test in accordance with ISO 2941, with the exception that the bubble point test before the collapse/burst test is not required.

8 Criteria for acceptance

The filter element shall be accepted if it passes the collapse/burst test in accordance with ISO 2941, after the completion of the required number of flow fatigue cycles and with the exception given in 7.12.

9 Data presentation

As a minimum, present all of the test data and calculation results mentioned in Clause 7. The format of the test report should be that of the example given in Table 2.

10 Identification statement (reference to this International Standard)

Use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard:

"Method of determining filter element resistance to flow fatigue using particulate contaminant conforms to ISO 3724:2007, *Hydraulic fluid power — Filter elements — Determination of resistance to flow fatigue using particulate contaminant*."

Table 2 — Data and calculation results from determination of resistance of filter element to flow fatigue particulate contaminant — Example format

Test laboratory: ____________________ **Test date:** ________ **Operator:** ________

Filter and element identification

Element identification number: ____________ Filter housing identification number: ____________

Spin-on canister: Yes _____ No _____ Minimum element bubble point: ________ Pa

Operating conditions

Test fluid

Type: ____________________ Ref.: ____________________ Batch no.: __________

Viscosity at the test temperature: ____________ mm^2/s Test temperature: __________ °C

Test contaminant

Type: ____________________ Batch no.: __________

Test system

Maximum flow rate, q: __________ l/min Maximum element differential pressure: ______________ kPa

Test results

Element integrity

Bubble point according to ISO 2942: ____________ Pa Pass ☐ Fail ☐ Wetting fluid: __________

Differential pressure (Δp) at test flow rate(s) — include filter housing and calculated final assembly curves in accordance with ISO 3724:2007, 7.4 to 7.6:

Flow rate, q**:** ____________ l/min

Filter housing differential pressure, Δp_H: __________________ kPa

Maximum element differential pressure, Δp_E: __________________ kPa

Maximum assembly differential pressure, Δp_A: __________________ kPa

Test waveform (include recorded differential-pressure-versus-time trace conforming to ISO 3724:2007, Figure 1)

Number of cycles completed ______________ **Cycle frequency** __________________ Hz

Results of filter element collapse/burst test in accordance with ISO 2941 (see ISO 3724:2007, 7.12): (*include all data required in ISO 2941*)

Annex A
(informative)

Data from round robin tests performed to verify the ISO 3724 procedure

A.1 Background

In the winter of 1999, an international round robin test was conducted, with eight laboratories from several countries initially participating. At that time, the committee draft of this edition of ISO 3724 included the option of using high viscosity fluid instead of particulate contaminant to generate the terminal element differential pressure. Each laboratory was instructed to test two filter elements in accordance with the ISO 3724 procedure using ISO medium test dust (according to ISO 12103-1) and two elements using a high viscosity fluid.

A.2 Round robin test procedure

The rated flow rate was 70 l/min, the terminal element differential pressure was 355 kPa (3,55 bar), and the required number of flow fatigue cycles was 50 000. All laboratories were asked to use ISO medium test dust (according to ISO 12103-1) with a fluid with a viscosity grade of ISO VG 32 (according to ISO 3448) for two filter elements and, for the remaining two elements, only a fluid with a viscosity grade of ISO VG 320 or 460. After completion of the 50 000 flow fatigue cycles, all elements were to be subjected to a collapse/burst test in accordance with ISO 2941.

A.3 Summary

Seven of the eight laboratories completed testing and submitted data that included the following:

— results of fabrication integrity tests performed in accordance with ISO 2942;

— traces of the flow fatigue cycle waveform;

— data related to this annex.

Four of the eight laboratories submitted data that included the following:

— results and tracing of the collapse/burst test performed in accordance with ISO 2941.

A total of 22 individual tests were conducted:

— 14 of the tests used test dust to challenge the filter element;

— eight of the tests used high viscosity fluid to challenge the filter element;

— 43 % (six out of 14) of the tests that used test dust were terminated prior to reaching the required 50 000 flow fatigue cycles due to apparent filter media failure;

— all of the tests that used high viscosity fluid completed the required 50 000 flow fatigue cycles.

A.4 Observations

A.4.1 The filter element construction apparently was not suitable for the required 50 000 flow fatigue cycles at 355 kPa (3,55) bar when test dust was used, as six out of 14 filter elements failed to reach the required level.

A.4.2 High viscosity fluid does not appear to stress the filter element media as much as test dust does, as 100 % of the elements tested with high viscosity fluid completed the required 50 000 flow fatigue cycles.

A.4.3 Filter elements generally had a higher bubble point immediately after flow fatigue testing using the high viscosity fluid (see results from laboratories 2, 4 and 5). Intra-lab average collapse/burst pressure is also typically higher (see results from laboratories 2 and 4).

A.4.4 Laboratory 2 used the highest viscosity fluid for both tests and obtained generally higher bubble points and collapse/burst pressures (see Table A.1).

A.4.5 Fabrication integrity testing (bubble point) immediately after flow fatigue testing does not appear to provide a good indication of element collapse pressure. Two filter elements from laboratory 2 had bubble points that were equivalent to 25 % of their original value and still managed high final collapse pressures (i.e. greater than 1 000 kPa). One element each from laboratories 5 and 10 also exhibited this characteristic.

A.4.6 Only three of the 22 tests conducted took advantage of the provision for testing at 25 % of the rated flow rate (see 7.4). All other tests were conducted at 64 % of rated flow rate or higher.

A.4.7 Nearly all of the laboratories met the waveform requirements according to Figure 1.

A.5 Round robin test data

See Table A.1

Table A.1 — Data from round robin test performed to verify ISO 3724 procedure

Lab no.	First bubble mbar	Challenge type	Viscosity cSt @ °C	Flow rate l/min	Cycle rate Hz	Number of cycles	Next bubble mbar	Collapse pressure kPa	Final bubble mbar
1	34	ISO MTD	32 @ 40	70	0,5	15 500	3,5	Not run	—
1	33	ISO MTD	32 @ 40	70	0,5	16 000	3,5	Not run	—
Comment from Laboratory 1: *Added more than 200 g ISO medium test dust for both tests; after approximately 1 600 pulses, the filter medium was completely disrupted.*									
2	22,5	ACFTD	72 @ 23,5	70	0,5	50 000	5,8	1 185	4,5
2	20,5	ACFTD	72 @ 23,5	70	0,5	50 000	5,8	1 203	4,3
2	20,7	High visc.	726 @ 26	20-30	0,2	50 000	20,5	1 400	6,5
2	18,5	High visc.	726 @ 26	20-30	0,2	50 000	18	1 230	6,8
4	21,8 (29 fizz)	ISO MTD	32 @ 38	70	0,5	10 000	4,2 (4,7 fizz)	Not run	—
4	22 (30 fizz)	ISO MTD	32 @ 38	70	0,3	7 000	4,2 (4,6 fizz)	Not run	—
4	22,5 (29 fizz)	High visc.	160 @ 60	70	0,5	50 000	4,6 (9,6 fizz)	Not run	—
4	22,4 (29,7 fizz)	High visc.	169 @ 59	70	0,5	50 000	5,2 (13,7 fizz)	Not run	—
5	31	ISO MTD	32 @ 40	60-70	0,5	50 000	not run	931	6
5	25,6	ISO MTD	32 @ 40	60-70	0,5	50 000	not run	1 310	5
5	25,6	High visc.	400 @ 21	23-26	0,5	50 000	15	1 241	5,5
5	29,9	High visc.	220 @ 30	64-70	0,5	50 000	7,2	1 310	5,5
7	Comment from Laboratory 7: *Could not maintain differential pressure; test using high viscosity fluid was preferred.*								
8	18,8	ISO MTD	32 @ 40	70	0,5	50 000	Not run	882	5,73
8	29,9	ISO MTD	32 @ 40	70	0,5	50 000	Not run	774	5,23
8	27,4	High visc.	852 @ 23	—	—	—	—	—	—
Comment from Laboratory 8: *Could not obtain acceptable waveform with high viscosity fluid.*									
10	21	ISO MTD	16 @ 42	48	1	50 000	20	557	Unknown
10	22	ISO MTD	16 @ 42	48	1	50 000	5	729	5
10	22	High visc.	400 @ 40	45	1	50 000	8	1 013	3
10	22	High visc.	400 @ 40	50	1	50 000	5	456	3
11	23,9	ISO MTD	23 @ 20	70	0,08	14 977	3,8	—	—
11	24	ISO MTD	23 @ 20	70	0,16	10 694	4,4	—	—

A.6 Conclusions

The round robin test programme used to verify the procedure specified in the committee draft of this International Standard was successful in that it resulted in the elimination of high viscosity fluid as a test option and the constraining of the viscosity of the test fluid to 14 mm^2/s to 32 mm^2/s, as it appears that high viscosity fluid does not stress the filter element to the same degree as particulate contaminant.

Bibliography

[1] ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

[2] ISO 5725-1:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[3] ISO 5725-2:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

[4] ISO 5725-3:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*

[5] ISO 5725-4:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 4: Basic methods for the determination of the trueness of a standard measurement method*

[6] ISO 5725-6:1994, *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*

[7] NFPA/T3.10.8.7 R1-1998 (R2004), *Hydraulic fluid power — Filter elements — Method for verifying the flow fatigue characteristics*

[8] ISO 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

ICS 23.100.60

Price based on 12 pages